[0007] In yet another aspect, a method involves: evacuating a negative-pressure barrel of a device, the evacuated negative-pressure barrel having an aperture membrane sealing an aperture at a distal end of the negative-pressure barrel, and a housing affixed to, and sealing, a proximal end of the negative-pressure barrel, wherein the negative-pressure barrel contains an accelerator barrel positioned lengthwise within the negative-pressure barrel with an open proximal end fixed to the housing and opening into a chamber within the housing, and having an open distal end proximate to, and aligned with, the aperture; arming a trigger valve situated between the chamber and the open proximal end of the accelerator barrel, the armed trigger valve forming a hydrostatic boundary between chamber and the open proximal end of the accelerator barrel; configuring a micro-particle within the accelerator barrel at a launch point proximate to the trigger valve; by abruptly releasing the armed trigger valve, abruptly releasing pressurized gas from the chamber and into the open proximal end of the accelerator, wherein, the abruptly released pressurized gas is configured to accelerate the micro-particle from the launch point to the open distal end of the accelerator barrel and through the aperture with sufficient momentum to pierce through the aperture membrane and penetrate a sufficient depth of dermal tissue proximate to the distal end of the negative-pressure barrel to induce a micro-emergence of blood at the dermal tissue surface; and drawing at least a portion of blood from the micro-emergence into the evacuated negative-pressure barrel through the pierced aperture.

[0008] In yet one further aspect, a method involves: configuring a micro-particle at a launch point at a proximal end of an accelerator barrel of a hand-portable hyperspeed micro-particle accelerator device, wherein the accelerator barrel is positioned lengthwise within an outer barrel of the hand-portable hyperspeed micro-particle accelerator device and has an open distal end proximate to, and aligned with, an aperture at a distal end of the outer barrel; arming the hand-portable hyperspeed micro-particle accelerator device for hyperspeed acceleration of the micro-particle; and triggering the armed hand-portable hyperspeed micro-particle accelerator device to cause the micro-particle to accelerate from the launch point to the open distal end of the accelerator barrel and through the aperture with sufficient momentum to pierce dermal tissue proximate to the distal end of the outer barrel with no larger than a dermal-pore-sized surface puncture.

[0009] These as well as other aspects, advantages, and alternatives, will become apparent to those of ordinary skill in the art by reading the following detailed description, with reference where appropriate to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1**A is an example device for needle-free blood draw displayed in an example use context, in accordance to an example embodiment.

[0011] FIG. **1**B is an example device for needle-free blood draw displayed in an example use context, in accordance to an alternative example embodiment.

[0012] FIG. **2** is a block diagram of a device for needle-free blood draw, according to an example embodiment.

[0013] FIG. **3** is an example schematic representation device for needle-free blood draw, according to an example embodiment.

[0014] FIG. **4** is an example schematic representation device for needle-free blood draw, according to an alternative example embodiment.

[0015] FIG. **5** is a flowchart of an example method of needle-free blood draw using a device for needle-free blood draw, according to an example embodiment.

DETAILED DESCRIPTION

[0016] In the following detailed description, reference is made to the accompanying figures, which form a part hereof. In the figures, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, figures, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the scope of the subject matter presented herein. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the figures, can be arranged, substituted, combined, separated, and designed in a wide variety of different configurations, all of which are explicitly contemplated herein.

[0017] Further, while embodiments disclosed herein make reference to use on or in conjunction with a living human body, it is contemplated that the disclosed methods, systems and devices may be used in any environment where needle-free drawing of blood, and/or needle-free, sub-dermal delivery of diagnostic and/or therapeutic substance, is desired. The environment may be any living or non-living body or a portion thereof, a fluid conduit, a fluid reservoir, etc.

1. OVERVIEW

[0018] Some types of medical testing involve analysis of very small blood samples from a person (e.g., a medical patient). For example, monitoring of a blood-sugar level may be able to be achieved with just a tiny droplet of blood (e.g., a fraction of a milliliter). Common techniques of medical blood extraction typically entail piercing the dermal tissue (skin) with a small needle or lancet (a "piercing element"), and collecting blood from the puncture point. In the case of a hollow needle, collection may be made below the skin, in a vein or capillary for example. For a lancet or non-hollow needle, collection may be made at the skin surface as the blood emerges.

[0019] Generally, the smaller the puncture, the smaller the degree of discomfort that may accompany a blood draw. Consequently, very small diameter needles or lancets may be considered advantageous for purposes at least of comfort of the patient. In practice, small piercing elements can be integrated in small, hand-portable implements that can be used by a healthcare practitioner, or even the patient, to collect a small sample of the patient's blood and provide it to a lab for testing.

[0020] While decreasing the size (e.g., diameter) of a piercing element can help decrease discomfort, it can also reduce the tensile strength of the piercing element so that it can no longer pierce dermal tissue, but bends or breaks when applied instead. In particular, the size limit at which the tensile strength of a piercing element is no longer sufficient to reliably pierce dermal tissue may still be larger than that at which the discomfort associated with piercing dermal tissue vanishes or becomes imperceptible. Accordingly, example embodiments disclosed herein provide an example device and technique for medical extraction of blood that can imperceptibly pierce dermal tissue without a piercing element.

[0021] In one example, a small, device can include a pneumatic particle accelerator for imparting a micro-particle with a sufficient momentum to cause it to pierce dermal tissue deep